UA-319

WE CLAIM:

1. A supramolecular structure produced by the process comprising:

reacting a multi-generation dendrimer with a monomer, where the dendrimer comprises a core molecule, a plurality of interior generations spherically disposed around the core molecule and an outermost generation comprising a plurality of dendritic branches having terminal groups sufficiently reactive to undergo addition or substitution reactions, where the monomer introduces a labile bond and at least one cross-linkable moiety to the terminal groups of each dendritic branch, and where the cross-linkable moiety is bonded to the terminal group via the labile bond;

cross-linking the cross-linkable moieties of adjacent dendritic branches; and

cleaving the labile bonds, thereby freeing the dendrimer and forming a molecule encapsulated within a cross-linked shell molecule.

2. The supramolecular structure produced by claim 1, wherein the dendrimer is selected from the group consisting of poly(propylenimine) (DAB) and polyamidoamine (PAMAM) dendrimers.

3. The supramolecular structure produced by claim 1, wherein the monomer is a trialkenesilane.

4. The supramolecular structure produced by claim 3, wherein the trialkenesilane is a trialkenechlorosilane.

5. The supramolecular structure produced by claim 4, wherein the trialkenechlorosilane is selected from the group consisting of

trivinylchlorosilane, triallychlorosilane, tripropargylchlorosilane and diallylchlorosilane.

6. The supramolecular structure produced by claim 1, wherein the labile bond is selected from the group consisting of silicon-oxygen, silicon-oxygen-carbon, oxygen-nitrogen, nitrogen-silicon, nitrogen-carbonyl-nitrogen, silicon-acetylene, amide, blocked isocyanates and ureas.

7. The supramolecular structure produced by claim 6, wherein the labile bond is a nitrogen-silicon bond.

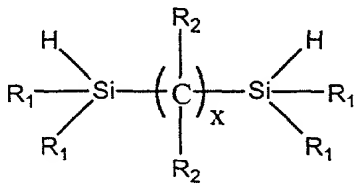
8. The supramolecular structure produced by claim 1, wherein the cross-linking method is selected from group consisting of hydrosilation, olefin metathesis, radical polymerization, polycondensation, anionic polymerization, cationic polymerization and coordination polymerization.

9. The supramolecular structure produced by claim 1, wherein the cross-linkable moieties are cross-linked with a cross-linking agent.

10. The supramolecular structure produced by claim 8 wherein the crosslinking method is hydrosilation.

11. The supramolecular structure produced by claim 9, wherein cross-linking agent is selected from double and multiple cross-linking agents.

12. The supramolecular structure produced by claim 11, wherein the double cross-linking agent is of the general formula (I):



(I)

wherein where R_1 is selected from the group consisting of hydrogen or organic groups having from about 1 to about 30 carbon atoms, R_2 is selected from the group consisting of hydrogen and organic groups having from about 1 to about 30 carbon atoms, and x is an integer from about 1 to about 4. Preferably R_1 is selected from the group consisting of hydrogen or organic groups having from about 1 to about 15 carbon atoms, R_2 is selected from the group consisting of hydrogen and organic groups having from about 1 to about 15 carbon atoms, and x is an integer form about 1 to about 2.

13. The supramolecular structure produced by claim 11, wherein the multiple cross-linking agent is selected from the group consisting of $CH_3Si(CH_2CH_2Si(CH_3)_2H)_3$; $CH_3(CH_2SiH_2)_2CH_3$; $HC(Si(R^1)_2H)_3$; $Si(R^1)_2H_2$; $(SiR^1HO)_4$; linear polymers selected from the group consisting of $(CH_3)_3Si\text{-}O\text{-}(SiR^2H\text{-}O)_n\text{-}Si(CH_3)_3$, $H(CH_3)_2Si\text{-}O\text{-}(SiPH(\text{-}OSi(CH_3)_2H)\text{-}O)_n\text{-}Si(CH_3)_2H$, $(CH_3)_3Si\text{-}O\text{-}(Si(CH_3)(H)\text{-}O)_m\text{-}(Si(CH_3)(C_8H_{17})\text{-}O)_n\text{-}Si(CH_3)_3$, and $H_2R^3Si(SiR^3H)_n\text{-}SiR^3H_2$; cyclic compounds; a dendrimer; and mixtures thereof; wherein

R^1 is selected from hydrogen and organic groups having from about 1 to about 15 carbon atoms;

R^2 is selected from methyl and ethyl groups;

R^3 is selected from aryl and alkyl groups having from about 1 to about 15 carbon atoms;

n is a positive integer from about 10 to about 100; and

m is a positive integer from about 10 to about 100.

14. The supramolecular structure produced by claim 8, wherein olefin metathesis includes the use of a ring opening metathesis polymerization (ROMP) catalyst.

15. The supramolecular structure produced by claim 8, wherein olefin metathesis includes the use of a acyclic diene metathesis (ADMET) catalyst.

16. The supramolecular structure produced by claim 8, wherein the coordination polymerization is Ziegler Natta polymerization.

17. The supramolecular structure produced by claim 1, wherein the core dendrimer contains catalytic centers.

18. The supramolecular structure produced by claim 1, wherein the core dendrimer contains metallocores.

19. A process for producing a supramolecular structure comprising:

reacting a multi-generation dendrimer with a monomer, where the dendrimer comprises a core molecule, a plurality of interior generations spherically disposed around the core molecule and an outermost generation comprising a plurality of dendritic branches having terminal groups sufficiently reactive to undergo addition or substitution reactions, where the monomer introduces a labile bond and at least one cross-linkable moiety to the terminal reactive groups, and where the cross-linkable moiety is bonded to the terminal reactive group via the labile bond;

crosslinking the cross-linkable moieties of adjacent dendritic branches; and

cleaving the labile bonds, thereby freeing the dendrimer and forming a molecule encapsulated within a cross-linkable shell molecule.

20. The process of claim 19, wherein the dendrimer is selected from the group consisting of poly(propylenimine) (DAB) and polyamidoamine (PAMAM) dendrimers.

21. The process of claim 19, wherein the monomer is a trialkenesilane selected from the group consisting of trivinylchlorosilane, triallychlrosilane, tripropargylchlorosilane and diallylchlorosilane.

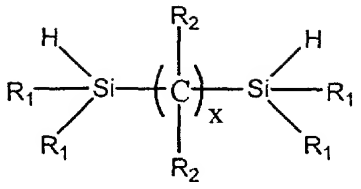
22. The process of claim 19, wherein the labile bond is selected from the group consisting of silicon-oxygen, oxygen-nitrogen, silicon-oxygen-carbon, nitrogen-carbonyl-nitrogen, nitrogen-silicon, silicon-acetylene, amide, blocked isocyanates and ureas.

23. The process of claim 19, wherein the cross-linking method is selected from group consisting of hydrosilation, olefin metathesis, radical polymerization, polycondensation, anionic polymerization, cationic polymerization and coordination polymerization.

24. The supramolecular structure produced by claim 19, wherein the cross-linkable moieties are cross-linked with a cross-linking agent.

25. The supramolecular structure produced by claim 24, wherein cross-linking agent is selected from double and multiple cross-linking agents.

26. The process of claim 25, wherein the double crosslinking agent is of the general formula (I):



(I)

wherein where R_1 is selected from the group consisting of hydrogen or organic groups having from about 1 to about 30 carbon atoms, R_2 is selected from the group consisting of hydrogen and organic groups having from about 1 to about 30 carbon atoms, and x is an integer from about 1 to about 4. Preferably R_1 is selected from the group consisting of hydrogen or organic groups having from about 1 to about 15 carbon atoms, R_2 is selected from the group consisting of hydrogen and organic groups having from about 1 to about 15 carbon atoms, and x is an integer form about 1 to about 2.

27. The process of claim 19, wherein the multiple cross-linking agent is selected from the group consisting of $CH_3Si(CH_2CH_2Si(CH_3)_2H)_3$; $CH_3(CH_2SiH_2)_2CH_3$; $HC(Si(R^1)_2H)_3$; $Si(R^1)_2H_2$; $(SiR^1HO)_4$; linear polymers selected from the group consisting of $(CH_3)_3Si\text{-}O\text{-}(SiR^2H\text{-}O)_n\text{-}Si(CH_3)_3$, $H(CH_3)_2Si\text{-}O\text{-}(SiPH(\text{-}OSi(CH_3)_2H)\text{-}O)_n\text{-}Si(CH_3)_2H$, $(CH_3)_3Si\text{-}O\text{-}(Si(CH_3)H\text{-}O)_m\text{-}(Si(CH_3)(C_8H_{17})\text{-}O)_n\text{-}Si(CH_3)_3$, and $H_2R^3Si(SiR^3H)_n\text{-}SiR^3H_2$; cyclic compounds; a dendrimer; and mixtures thereof; wherein

R^1 is selected from hydrogen and organic groups having from about 1 to about 15 carbon atoms;

R^2 is selected from methyl and ethyl groups;

R^3 is selected from aryl and alkyl groups having from about 1 to about 15 carbon atoms;

n is a positive integer from about 10 to about 100; and

m is a positive integer from about 10 to about 100.

28. A supramolecular structure comprising a dendrimer and a cross-linked shell molecule spherically disposed about the dendrimer, wherein the dendrimer and the cross-linked shell molecule are not ionically or covalently bonded together.

29. A supramolecular structure produced by the process comprising:

reacting a multi-generation dendrimer with a monomer, where the dendrimer comprises a core molecule, a plurality of interior generations spherically disposed around the core molecule and an outermost generation comprising a plurality of dendritic branches having terminal groups sufficiently reactive to undergo addition or substitution reactions, where the monomer introduces a labile bond and at least one cross-linkable moiety to the terminal groups, and where the cross-linkable moiety is bonded to the terminal group via the labile bond;

crosslinking the cross-linkable moieties of adjacent dendritic branches;

cleaving the labile bonds, thereby freeing the dendrimer and forming a molecule encapsulated within a cross-linked shell molecule; and

degrading and removing the free dendrimer, thereby producing a intramolecularly cross-linked spherical hollow shell structure.

30. The supramolecular structure produced by claim 29, wherein the dendrimer is selected from the group consisting of poly(propylenimine) (DAB) and polyamidoamine (PAMAM) dendrimers.

31. The supramolecular structure produced by claim 29, wherein the monomer is a trialkenesilane.

32. The supramolecular structure produced by claim 31, wherein the trialkenesilane is a trialkenechlorosilane.

33. The supramolecular structure produced by claim 32, wherein the trialkenechlorosilane is selected from the group consisting of trivinylchlorosilane, triallychlrosilane, tripropargylchlorosilane and diallylchlorosilane.

34. The supramolecular structure produced by claim 29, wherein the labile bond is selected from the group consisting of silicon-oxygen, oxygen-nitrogen, silicon-oxygen-carbon, nitrogen-carbonyl-nitrogen, nitrogen-silicon, silicon-acetylene, amide, blocked isocyanates and ureas.

35. The supramolecular structure produced by claim 34, wherein the labile bond is a nitrogen-silicon bond.

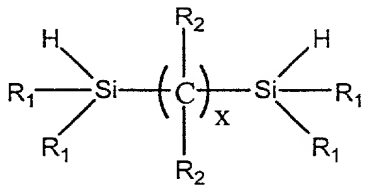
36. The supramolecular structure produced by claim 29, wherein the crosslinking method is selected from group consisting of hydrosilation, olefin metathesis, radical polymerization, polycondensation, anionic polymerization, cationic polymerization and coordination polymerization.

37. The supramolecular structure produced by claim 29, wherein the cross-linkable moieties are cross-linked with a crosslinking agent.

38. The supramolecular structure produced by claim 36, wherein the crosslinking method is hydrosilation.

39. The supramolecular structure produced by claim 37, wherein the cross-linking agent is selected from double and multiple cross-linking agents.

40. The supramolecular structure produced by claim 39, wherein the double cross-linking agent is of the general formula I:



(I)

wherein where R_1 is selected from the group consisting of hydrogen or organic groups having from about 1 to about 30 carbon atoms, R_2 is selected from the group consisting of hydrogen and organic groups having from about 1 to about 30 carbon atoms, and x is an integer from about 1 to about 4. Preferably R_1 is selected from the group consisting of hydrogen or organic groups having from about 1 to about 15 carbon atoms, R_2 is selected from the group consisting of hydrogen and organic groups having from about 1 to about 15 carbon atoms, and x is an integer form about 1 to about 2.

41. The supramolecular structure produced by claim 39, wherein the multiple cross-linking agent is selected from the group consisting of $CH_3Si(CH_2CH_2Si(CH_3)_2H)_3$; $CH_3(CH_2SiH_2)_2CH_3$; $HC(Si(R^1)_2H)_3$; $Si(R^1)_2H_2$; $(SiR^1HO)_4$; linear polymers selected from the group consisting of $(CH_3)_3Si\text{-}O\text{-}(SiR^2H\text{-}O)_n\text{-}Si(CH_3)_3$, $H(CH_3)_2Si\text{-}O\text{-}(SiPH(\text{-}OSi(CH_3)_2H)\text{-}O)_n\text{-}Si(CH_3)_2H$, $(CH_3)_3Si\text{-}O\text{-}(Si(CH_3)H\text{-}O)_m\text{-}(Si(CH_3)(C_8H_{17})\text{-}O)_n\text{-}Si(CH_3)_3$, and $H_2R^3Si(SiR^3H)_n\text{-}SiR^3H_2$; cyclic compounds; a dendrimer; and mixtures thereof; wherein

R^1 is selected from hydrogen and organic groups having from about 1 to about 15 carbon atoms;

R^2 is selected from methyl and ethyl groups;

R^3 is selected from aryl and alkyl groups having from about 1 to about 15 carbon atoms;

n is a positive integer from about 10 to about 100; and

m is a positive integer from about 10 to about 100.

42. The supramolecular structure produced by claim 36, wherein olefin metathesis includes the use of a ring opening metathesis polymerization (ROMP) catalyst.

43. The supramolecular structure produced by claim 36, wherein olefin metathesis includes the use of a acyclic diene metathesis (ADMET) catalyst.

44. The supramolecular structure produced by claim 36, wherein the coordination polymerization is Ziegler Natta polymerization.

45. A process for producing a supramolecular structure comprising:

reacting a multi-generation dendrimer with a monomer, where the dendrimer comprises a core molecule, a plurality of interior generations spherically disposed around the core molecule and an outermost generation comprising a plurality of dendritic branches having terminal groups sufficiently reactive to undergo addition or substitution reactions, where the monomer introduces at least one labile bond and a cross-linkable moiety to the terminal group of

each dendritic branch, and where the cross-linkable moiety is bonded to the terminal group via the labile bond;

crosslinking the cross-linkable moieties of adjacent dendritic branches;

cleaving the labile bonds, thereby freeing the core dendrimer and forming a molecule encapsulated within a cross-linked shell molecule; and

degrading and removing the free dendrimer, thereby producing a intramolecularly cross-linked spherical hollow shell structure.

46. The process of claim 45, wherein the dendrimer is selected from the group consisting of poly(propylenimine) (DAB) and polyamidoamine (PAMAM) dendrimers.

47. The process of claim 45, wherein the monomer is a trialkenesilane selected from the group consisting of trivinylchlorosilane, triallychlrosilane, tripropargylchlorosilane and diallylchlorosilane.

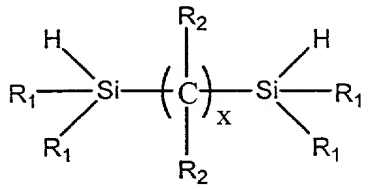
48. The process of claim 45, wherein the labile bond is selected from the group consisting of silicon-oxygen, oxygen-nitrogen, silicon-oxygen-carbon, nitrogen-carbonyl-nitrogen, nitrogen-silicon, silicon-acetylene, amide, blocked isocyanates and ureas.

49. The process of claim 45, wherein the cross-linking method is selected from group consisting of hydrosilation, olefin metathesis, radical polymerization, polycondensation, anionic polymerization, cationic polymerization and coordination polymerization.

50. The supramolecular structure produced by claim 45, wherein the cross-linkable moieties are cross-linked with a cross-linking agent.

51. The process of claim 50, wherein the cross-linking agent is selected from double and multiple cross-linking agents.

52. The process of claim 51, wherein the double cross-linking agent is of the general formula (I):



(I)

wherein where R_1 is selected from the group consisting of hydrogen or organic groups having from about 1 to about 30 carbon atoms, R_2 is selected from the group consisting of hydrogen and organic groups having from about 1 to about 30 carbon atoms, and x is an integer from about 1 to about 4. Preferably R_1 is selected from the group consisting of hydrogen or organic groups having from about 1 to about 15 carbon atoms, R_2 is selected from the group consisting of hydrogen and organic groups having from about 1 to about 15 carbon atoms, and x is an integer form about 1 to about 2.

53. The process of claim 51, wherein the multiple cross-linking agent is selected from the group consisting of $CH_3Si(CH_2CH_2Si(CH_3)_2H)_3$; $CH_3(CH_2SiH_2)_2CH_3$; $HC(Si(R^1)_2H)_3$; $Si(R^1)_2H_2$; $(SiR^1HO)_4$; linear polymers selected from the group consisting of $(CH_3)_3Si\text{-}O\text{-}(SiR^2H\text{-}O)_n\text{-}Si(CH_3)_3$, $H(CH_3)_2Si\text{-}O\text{-}(SiPH(\text{-}OSi(CH_3)_2H)\text{-}O)_n\text{-}Si(CH_3)_2H$, $(CH_3)_3Si\text{-}O\text{-}(Si(CH_3)H\text{-}O)_m\text{-}(Si(CH_3)(C_8H_{17})\text{-}O)_n\text{-}Si(CH_3)_3$, and $H_2R^3Si(SiR^3H)_n\text{-}SiR^3H_2$; cyclic compounds; a dendrimer; and mixtures thereof; wherein

R^1 is selected from hydrogen and organic groups having from about 1 to about 15 carbon atoms;

R^2 is selected from methyl and ethyl groups;

R^3 is selected from aryl and alkyl groups having from about 1 to about 15 carbon atoms;

n is a positive integer from about 10 to about 100; and

m is a positive integer from about 10 to about 100.

54. A supramolecular structure comprising a hollow cross-linked shell molecule.

55. A supramolecular structure comprising a dendrimer having a cross-linked peripheral surface.